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INTRODUCTION

The Resource Assessment Investigation of the Mariana Archipelago (RAIOMA) was a 5-year program initiated by the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, in 1980 to quantify the distribution and sustainable yield of insular fishery resources with commercial potential in the Mariana Archipelago.

To identify fishery resources with commercial value or potential, data from the commercial landings collected by the Governments of Guam and the Commonwealth of the Northern Marianas together with data from earlier research cruises were used to rank species relative to their economic potential and their importance to the subsistence fishery. Based on this ranking four species groups were identified as important fishery resources in the Marianas: tunas, deepwater snappers and groupers, deepwater shrimps, and akule (Polovina[1]).

The tuna resource has the greatest economic potential, but an assessment of the tunas in the Marianas would require an assessment of the tuna stocks in the western Pacific which was beyond the scope of the program. Thus, information on the tuna resource in the Marianas was obtained from historical catch and effort statistics provided by Japanese longliners and baitboats operating in the fishery conservation zone (FCZ) around the Marianas (Polovina and Shippen[2]).

The insular resources were assessed by a field program which consisted of six cruises, each of 40 days, using the NOAA ship Townsend Cromwell, from May 1982 through June 1984. On these cruises a systematic survey was conducted to measure geographic and seasonal variation of deepwater bottom fishes and shrimps at the 22 islands and banks labeled in Figure 1. Also, intensive fishing experiments were conducted to estimate catchability of the bottom fishes and shrimps. A collection of all specimens which appeared to represent new records was developed. Two aerial surveys were made in an attempt to estimate the abundance of akule in the Marianas. Finally bathymetric surveys were conducted and chartlets produced for 11 islands and banks where existing bathymetric data were insufficient for fishing and fishery assessment work (Polovina and Roush[3]).

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[1]Polovina, J. J. 1981. Planning document for the assessment of marine resources around Guam and the Commonwealth of the Northern Mariana Islands. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, Admin. Rep. H-81-10, 13 p.

[2]Polovina, J. J. and N. T. Shippen. 1983. Estimates of the catch and effort by Japanese longliners and baitboats in the fishery conservation zone around the Mariana Archipelago. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, Admin. Rep. H-83-1, 42 p.

[3]Polovina, J. J. and R. C. Roush. 1982. Charlets of selected fishing banks and pinnacles in the Mariana Archipelago. Southwest Fish. Cent. Honolulu Lab., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812, Admin. Rep. H-82-19, 15 p.

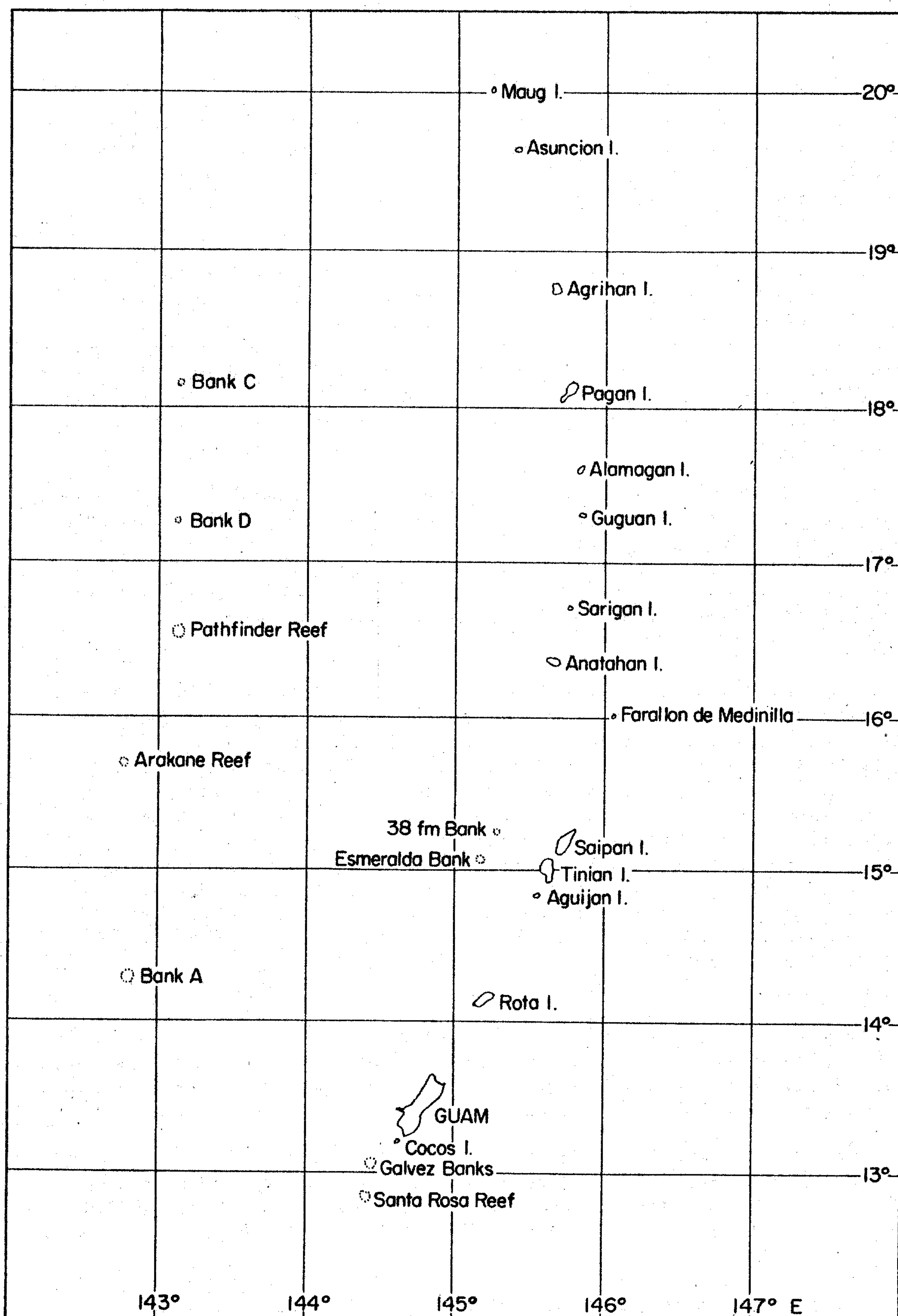

Figure 1.--The Marianas Archipelago with the 22 islands and banks sampled during the RAIOMA Program.

This report summarizes the main findings of the RAIOMA Program; a list of research publications is provided in Appendix I.

DEEPWATER SNAPPERS AND GROUPERS

At each island and bank, an attempt was made to conduct a systematic fishing survey of the bottom fish community in the 125-275 m depth range. A total of 7,621 bottom fishes of over 30 species were caught with handline gear during the six cruises. Gindai, *Pristipomoides zonatus*, accounted for 51.2% of the catch, and three species, gindai, yellowtail kalekale, *P. auricilla*, and ehu, *Etelis carbunculus*, accounted for 79.1% of the total catch (Polovina[4]).

Catch per unit effort (CPUE) was measured by the number of fish caught per line-hour. For each bank, bank CPUE was computed as the mean of all the drift CPUE values where a drift CPUE is the number of fish caught during an uninterrupted drift of the vessel while it is fishing in the 125-275 m depth range divided by the drift line-hours. The mean drift CPUE is presented for all 22 banks and islands in Table 1 and Figure 2.

Taken by bank type, the seamounts have the greatest mean drift CPUE (4.68 fish/line-h), followed by the northern islands (3.19 fish/line-h), and then the southern islands (2.46 fish/line-h). The main inhabited islands of the Marianas are Guam, Saipan, Rota, and Tinian--all in the southern group. Fishermen at these islands exploit the local stocks of bottom fishes which most likely account for the relatively low CPUE values for the islands. The mean of the bank CPUE for the uninhabited islands and banks in the southern group is 3.36 fish/line-h which suggests that when islands with heavy fishing mortality are excluded, there is no difference in bottom fish standing stock between the northern and unfished southern islands. The seamounts, however, appear to support a higher standing stock than the northern or southern islands and banks.

Bottom fish species were stratified by depth. The results summarized in Table 2 show that the centers of distribution for black ulua, *Caranx lugubris*, lehi, *Apharens rutilans*, and the yelloweye opakapaka, *P. flavipinnis*, and pink opakapaka, *P. filamentosus*, were between 164 and 183 m (90 and 100 fathoms). Similarly, yellowtail kalekale, kahala, *Seriola dumerili*, and gindai were most abundant between 183 and 201 m (100 and 110 fathoms). Species with deeper depth distributions, i.e., the mean depth of capture greater than 201 m (110 fathoms), were the pink kalekale, black grouper, *Epinephelus* sp., ehu, *Etelis carbunculus*, and onaga, *E. coruscans*. Studying each fishing bank individually showed that, overall, depth distributions were similar over the archipelago.

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[4]Polovina, J. J. Variation of catch rates and species composition in handling catches of deepwater snappers and groupers in the Mariana Archipelago. Submitted to Proceedings of the 5th Coral Reef Congress.

Table 1.--Bottom fish catch per unit effort (CPUE) and standard error (SE), by island and bank.

Bank	No. of drifts	Mean drift CPUE (numbers)	SE	Latitude N
Northern Islands and Banks				
Maug	7	5.03	1.02	20°02'
Asuncion	17	2.16	0.49	19°40'
Agrihan	45	4.20	0.31	18°46'
Pagan	100	4.57	0.40	18°06'
Alamagan	118	2.37	0.19	17°36'
Guguan	32	3.01	0.30	17°19'
Sarigan	28	2.82	0.37	16°43'
Anatahan	38	2.31	0.23	16°21'
38-Fathom	61	3.12	0.26	16°20'
Esmeralda	114	2.29	0.15	14°58'
Average drift CPUE		3.19		
Southern Islands and Banks				
Farallon de Medinilla	32	3.29	0.65	16°01'
Saipan	17	1.72	0.34	15°10'
Tinian	20	1.96	0.29	15°00'
Aguijan	13	3.84	0.98	14°52'
Rota	19	1.91	0.40	14°10'
Guam	20	1.53	0.35	13°25'
Galvez and Santa Rosa	41	2.95	0.31	13°00'
Average drift CPUE		2.46		
Seamounts				
Bank C	8	5.91	1.57	18°08'
Bank D	20	5.85	0.51	17°09'
Pathfinder	136	4.58	0.23	16°30'
Arakane	84	3.36	0.24	15°38'
Bank A	24	3.71	0.57	14°12'
Average drift CPUE		4.68		

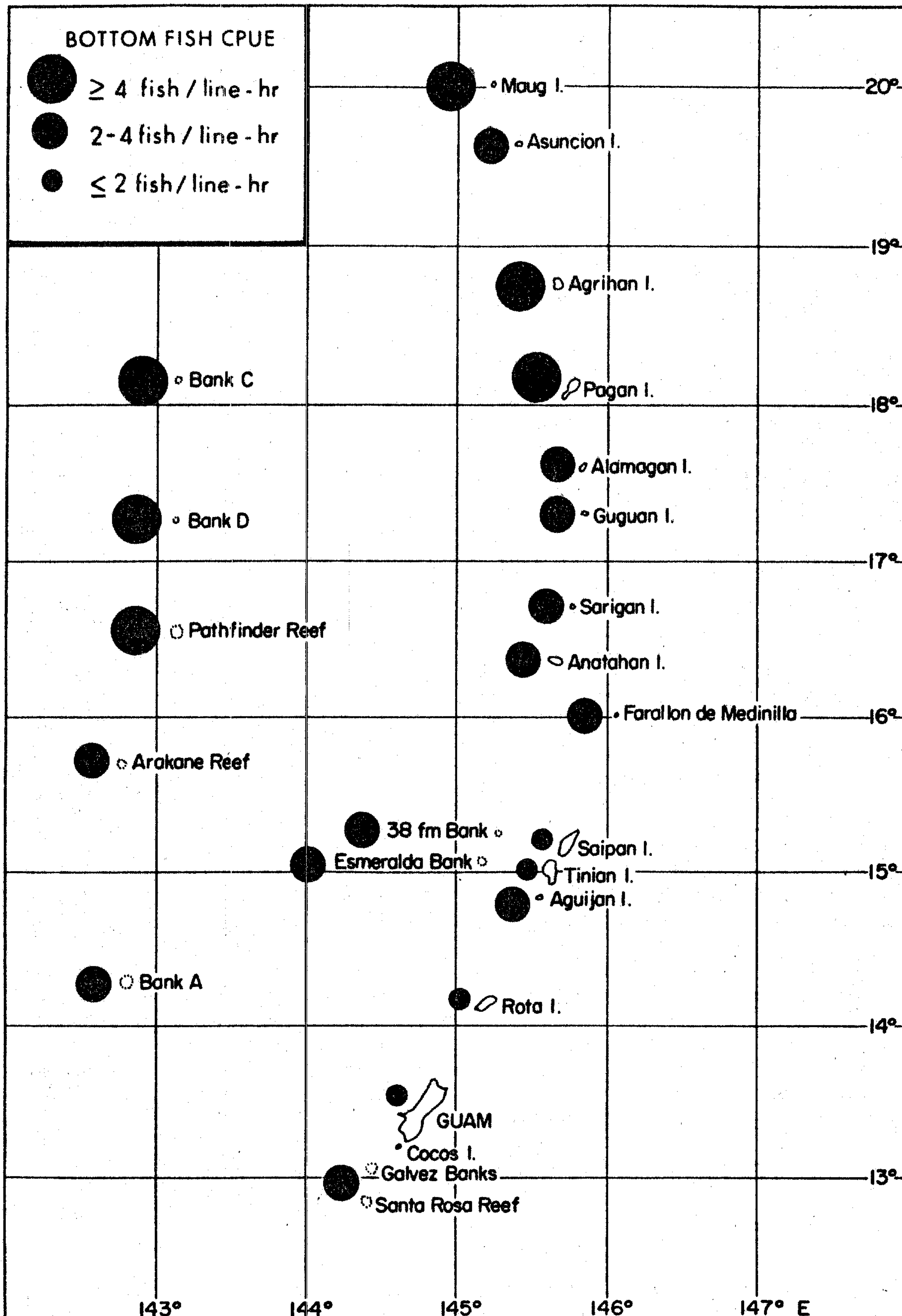

Figure 2.--The bottom fish CPUE grouped into three catch levels.

Table 2.--Mean depth of capture for the principal bottom fish species captured during the Resource Assessment Investigation of the Mariana Archipelago research cruises (N = sample size).

Species	Common name	Mean depth Meters	Mean depth Fathoms	N
Caranx lugubris	Black ulua	166	91	270
Pristipomoides flavipinnis	Yelloweye opakapaka	170	93	499
P. filamentosus	Pink opakapaka	170	93	191
Aphareus rutilians	Lehi	174	95	81
P. auricilla	Yellowtail kalekale	188	102	1,166
Seriola dumerili	Kahala	196	107	47
P. zonatus	Gindai	199	109	3,890
Epinephelus sp.	Black grouper	214	117	38
P. sieboldii	Pink kalekale	214	117	57
Etelis coruscans	Onaga	218	119	200
E. carbunculus	Ehu	225	123	950

The approach to yield estimation for the deepwater bottom fishes is described in detail in Polovina and Ralston.[5] Using an estimate of catchability obtained from an intensive fishing experiment and a measure of bottom fish habitat together with the estimated relative abundance from the systematic survey, the total bottom fish biomass which can be exploited with handline gear was computed. The Beverton and Holt (1956) yield equation, together with estimates of growth and mortality parameters obtained from otolith and size-frequency data, was used to first determine the age of entry for each of the major species which will maximize the yield per recruit. Then with the estimate of unexploited biomass the equilibrium yield was estimated as a function of fishing mortality. Also the change in the spawning stock biomass relative to its level in the absence of exploitation can be computed with the Beverton and Holt yield equation as a function of fishing mortality.

The equilibrium yield for the multispecies bottom fish complex fished with handline gear in the 125-275 m depth range for the 22 islands and banks of the Mariana Archipelago increases rapidly as a function of fishing mortality to a level of about 100 metric tons (MT) and beyond that exhibits a gradual increase with increasing fishing mortality (Table 3). In view of the flat-topped, yield curve which assumes constant recruitment and does not incorporate any economic considerations, an approach to determining the optimum equilibrium yield has been suggested (and adopted for several North Atlantic fisheries) as the yield corresponding to that level of effort where an increase of one unit of effort will increase the catch by 0.1 of the amount caught by the very first unit of effort (Gulland 1983, 1984).

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[5]Polovina, J. J. and S. Ralston. An approach to yield assessment for unexploited resources with application to snappers and groupers in the Marianas. [Manuscr. in prep.]

The value of $F_{0.1}$ for the bottom fish resource in the Marianas is estimated to be F = 1.0, and the corresponding annual equilibrium yield is 109 MT (Table 3). An approximate 95% confidence interval (CI) for this yield is 81-137 MT (see footnote 5). About 70% of this yield would come from the southern islands and banks, 27% would come from the northern chain, and only 3% from the seamounts (Table 4; Fig. 3). At a fishing mortality of 1.0, the spawning stock biomasses for the seven major species are reduced 20-42% of their unexploited levels. Although the spawner recruit curve for these species is unknown, as a generic lower bound, the spawning stock biomass should not be reduced below 20% of its unexploited level if a serious reduction of recruitment is to be avoided (Beddington and Cooke 1983).

Table 3.--Annual equilibrium bottom fish yield in metric tons (MT) for the age at entry which maximizes the yield per recruit for each species.

Fishing mortality (F)	Total yield (MT)
0.1	35
0.5	91
[1]1.0	109
1.5	114
2.0	116
2.5	116

[1]$F_{0.1}$ and $Y_{0.1}$ as defined by Gulland (1983).

The means of the annual equilibrium yield per nautical mile of 200-m contour for the northern banks, southern banks, and western seamounts are 212.9, 228.5, and 264.4 kg/nmi, respectively. The ratio of total yield for the archipelago to the total length of the 200-m contour is 222.4 kg/nmi (95% CI of 165.3-279.6 kg/nmi) (Table 4). These values suggest that the stocks in the Marianas are slightly less productive than those in Hawaii where a lower bound estimate of maximum sustainable yield of 272 kg/nmi of 200-m contour was obtained from a stock production model applied to commercial catch and effort data (not including the recreational fishing component) of snappers and groupers from Penguin Bank (Ralston and Polovina 1982).

If the entire archipelago is fished, _P_. _flavipinnis_ and _P_. _zonatus_ together will comprise about 50% of the catch (Table 5).

Over the period 1980-84 it is estimated that annual bottom fish landings have increased from 6 MT in 1980 to 20 MT in 1984 (Table 6). Although the location data were not always obtained for these data, it appears that 65-95% of this catch comes from around Guam and the remainder comes from Galvez Banks and Santa Rosa Reef south of Guam or areas in the Commonwealth of the Northern Marianas. Given the estimated equilibrium yield of 17.2 MT for Guam and that the CPUE around Guam is about one-half

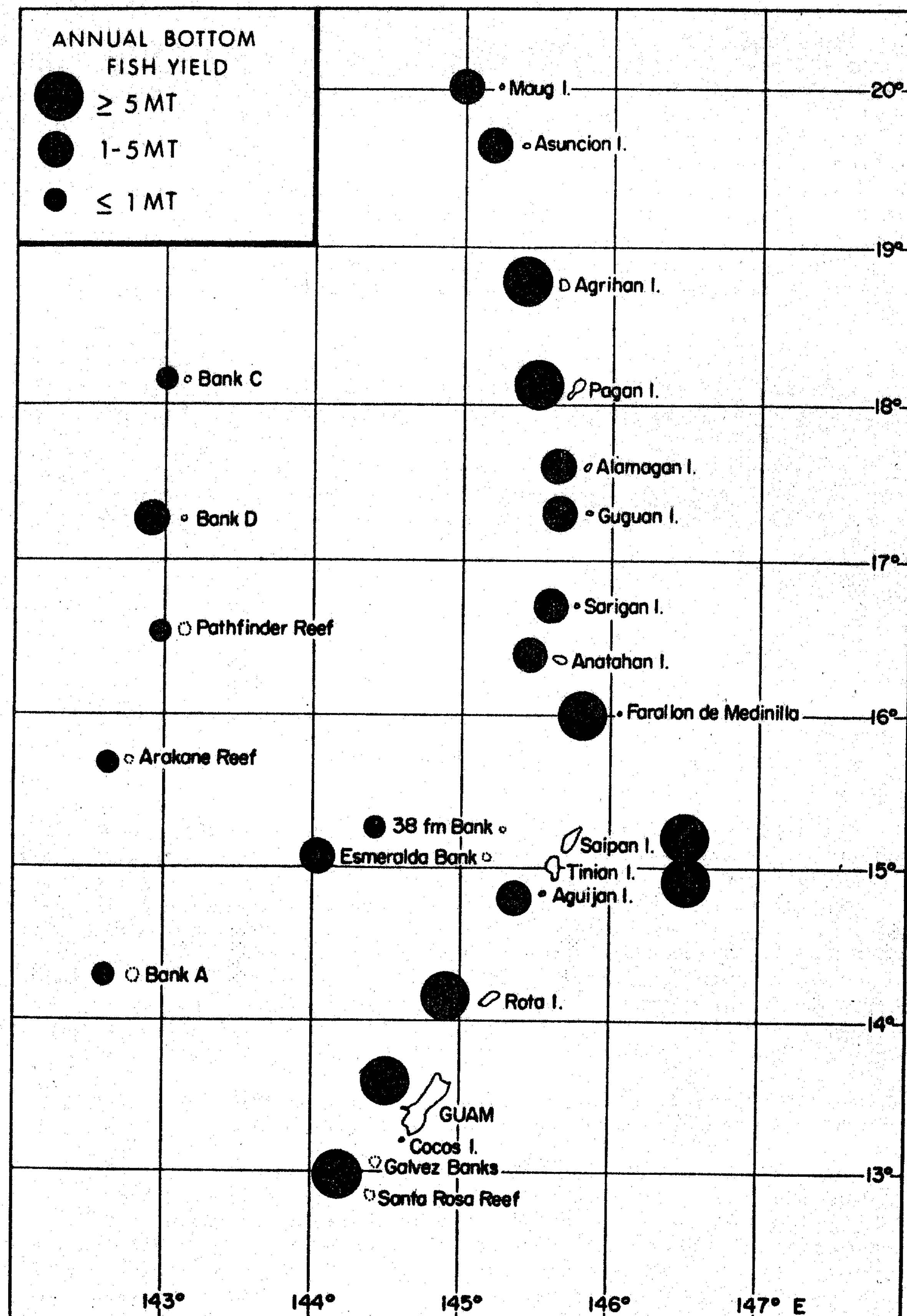

Figure 3.--Annual bottom fish yield grouped into three yield levels.

Table 4.--Annual equilibrium bottom fish yield and yield per nautical mile of 200-m contour for the age at entry which maximizes the yield per recruit at a level of fishing mortality of F = 1.0.

Bank	Total yield (MT/yr)		Yield (kg/yr)/nmi of 200-m contour
	Northern Islands and Banks		
Maug	2.7		262.2
Asuncion	2.1		188.4
Agrihan	5.6		303.6
Pagan	7.7		255.1
Alamagan	2.0		177.6
Guguan	1.7		179.0
Sarigan	1.6		193.8
Anatahan	2.5		144.2
38-Fathom	0.5		187.3
Esmeralda	2.9		237.4
Total	29.3	Mean	212.9
	Southern Islands and Banks		
Farallon de Medinilla	16.7		216.6
Saipan	13.4		254.1
Tinian	8.8		303.9
Aguijan	4.2		266.7
Rota	6.1		192.2
Guam	17.2		201.6
Galvez and Santa Rosa	8.6		164.2
Total	76.0	Mean	228.5
	Seamounts		
Bank C	0.9		288.2
Bank D	1.1		351.2
Pathfinder	0.9		303.5
Arakane	0.6		199.6
Bank A	0.6		179.7
Total	4.1	Mean	264.4

Total yield from all banks: 109 MT per year.

Table 5.--The percentage of annual sustainable yield by species group for fishing mortality of 1.0/year at age of entry which maximizes yield per recruit.

Species groups	Annual sustainable yield (%)
Caranx lugubris	8.3
Pristipomoides filamentosus	8.2
P. auricilla	7.3
P. flavipinnis	28.7
P. zonatus	23.1
Etelis coruscans	5.0
E. carbunculus	5.9
Others	13.5

Table 6.--Estimates of Guam fish landings 1980-84 (in MT).[1]

Year	Pelagic species (MT)	Deep bottom fish (MT)
1980	198	6
1981	223	12
1982	240	9
1983	189	11
1984[2]	265	20

[1]Based on data from the Southwest Fisheries Center Honolulu Laboratory's Western Pacific Fishery Information Network file on the Guam Division of Aquatic and Wildlife Resources offshore creel survey. Confidence interval ±30% of catch for pelagics and ±50% of catch for bottom fish.

[2]Estimate expanded from data from period June-September 1984.

of the archipelago average, it appears that Guam is already fished at its maximum sustainable yield and most probably overfished on the leeward coast. There may be an opportunity to increase the yield with more fishing effort directed toward Galvez Banks and Santa Rosa Reef, but most of the additional yield potential lies in the islands and banks to the north of Guam (Table 4).

The commercial landings at Saipan have ranged from 4 to 10 MT, compared with the estimate of equilibrium yield of 29 MT from Saipan, Tinian, Aguijan, and Esmeralda Bank (Tables 4 and 7). These sites are all within

Table 7.--Estimates of the Commonwealth of the Northern Mariana Islands commercial landings 1981-83 (in MT).[1]

Year	Pelagic species (MT)	Deep bottom fishes (MT)
1981	40.8	5.3
1982	47.2	3.7
1983	89.2	6.4
1984	123.8	9.9

[1]Data from the Southwest Fisheries Center Honolulu Laboratory's Western Pacific Fishery Information Network.

30 miles of Saipan suggesting that there is an opportunity to increase bottom fish landings from Saipan, Tinian, Aguijan, and Esmeralda Bank with a bottom fishing fleet operating out of Saipan and Tinian.

Based on the catchability estimated from the intensive fishing experiment, the fishing mortality of 1.0 per year is equivalent to an annual fishing effort of 74,153 line-h. Thus, for example, 15 small vessels each with two electric or hydraulic gurdies which fish 12 h a day for 200 days a year can achieve this level of fishing effort and would have a fleet catch rate of 1.5 kg/line-h with an annual average catch of 7.3 MT per vessel.

DEEPWATER SHRIMP

Sampling for deepwater shrimp targeted on the Heterocarpus species found in depths from 360 to 900 m (about 200 to 500 fathoms). The sampling gear consisted of Quonset[6] hut shaped traps about 90 by 66 cm at the base and a height of 46 cm. The frame is made of "rebar" and is covered with a wire mesh which is then covered on the top and two sides with a canvas cover. The entrances to the trap are two cones on opposite sides of the trap. Five traps were used on a string with a separation of about 40 m between traps. The traps were baited with mackerel.

The shrimp catches were primarily Heterocarpus ensifer, H. laevigatus, and H. longirostrus which are stratified by depth (Table 8). The catch rates of H. laevigatus were the highest of the three species and were greatest in the depth range 500-825 m.

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[6]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 8.--Depth stratification for the Heterocarpus species.

Depth: Meters	Depth: Fathoms	Catch per unit effort (kg/trap)
	Heterocarpus ensifer	
320	175	0
366	200	0.18
412	225	0.15
458	250	0.10
503	275	0.09
549	300	0.02
595	325	0.02
640	350	0.03
686	375	0
732	400	0
	Heterocarpus laevigatus	
366	200	0
412	225	0.08
458	250	0.01
503	275	0.62
548	300	2.10
595	325	1.95
640	350	1.75
686	375	1.93
732	400	1.64
778	425	2.33
824	450	1.10
869	475	0.87
915	500	0.36
961	525	0.05
1,006	550	0.02
1,052	575	0.02
	Heterocarpus longirostris	
824	450	0
869	475	0.11
915	500	0.29
961	525	0.38
1,006	550	0.46
1,052	575	0.75
1,098	600	0.63

A systematic survey of the relative abundance of _Heterocarpus_ species in the 500-825 m depth range found little seasonal variation but considerable variation in CPUE between banks. As with the bottom fishes, the seamounts had the highest catch rates (2.37 kg/trap-night) followed by the northern islands and banks (2.01 kg/trap-night) and then the southern islands and banks (1.39 kg/trap-night) (Table 9; Fig. 4).

A growth equation for _H. laevigatus_ was estimated from a time series of length-frequency data and estimates that the shrimp become susceptible to trap fishing at age 2 and that the females become sexually mature at age 4.5 (Moffitt and Polovina[7]). Yield-per-recruit analysis indicates that an age of entry of 2 maximizes the yield per recruit. The Beverton and Holt yield equation estimates equilibrium yield as a function of fishing mortality and the ratio of spawning stock biomass under exploitation to the unexploited spawning stock biomass (Table 10). At a fishing mortality of $F = 0.5$, the spawning stock is reduced to 20% of its original level in the absence of exploitation which has been suggested as a generic lower bound before a substantial decrease in recruitment may occur (Beddington and Cooke 1983). At $F = 0.5$ the equilibrium yield from the entire archipelago in the 500-825 m depth range is estimated at 162 MT, with a 95% CI of 102-218 MT, which would almost exclusively consist of _H. laevigatus_. About 85% of this yield would come from the southern islands and banks, 13% from the northern islands and banks, and about 2% from the seamounts (Table 11; Fig. 5).

Although there have been several short-lived attempts to harvest deepwater shrimp around Guam, there is currently no shrimp fishing around Guam or anywhere else in the Marianas. Given that the catch rates around Guam are less than 50% of the catch rates at most other banks, any shrimp fishing should target areas other than Guam. In the southern islands the best shrimp fishing areas are Saipan, Tinian, and Aguijan (Table 9). Although Galvez Banks and Santa Rosa Reef south of Guam have good catch rates the strong currents encountered there during the assessment work resulted in considerable trap loss.

The estimated catchability from the intensive trapping and the F of 0.5 correspond to an effort of 280 trap-nights/nmi^2. Given a total habitat of 800 nmi^2 from 500 to 825 m, an annual effort of 224,000 trap-nights would produce the fishing mortality of 0.5 for the entire archipelago. Thus, for example, 28 small vessels which each set 40 traps/night for 200 nights/year would produce this effort and have an average fleet catch rate of 0.7 kg per trap-night and an average annual landing of 5.8 MT per vessel.

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[7]Moffitt, R. B. and J. J. Polovina. The distribution and yield assessment of the deepwater shrimp resource in the Marianas. [Manuscr. in prep.]

Table 9.--Catch rates and habitat for <u>Heterocarpus</u> in the 500-825 m depth range.

Bank	Catch per unit effort (kg/trap)	Area (nmi^2) (500-825 m)
	Northern Islands and Banks	
Maug	1.88	3.83
Asuncion	2.11	5.93
Aguijan	1.96	12.39
Pagan	2.17	16.19
Alamagan	2.18	11.43
Guguan	2.52	5.60
Sarigan	1.45	4.55
Anatahan	2.36	10.89
38-Fathom	2.12	6.37
Esmeralda	1.35	2.03
Mean: 2.01		
	Southern Islands and Banks	
Farallon de Medinilla	0.97	88.55
Saipan	2.06	213.99
Tinian	1.81	73.80
Aguijan	1.61	39.36
Rota	1.02	197.31
Guam	0.72	44.24
Galvez and Santa Rosa	1.78	50.77
Mean: 1.39		
	Seamounts	
Bank C	2.07	2.71
Bank D	2.72	2.71
Pathfinder	2.79	2.71
Arakane	1.91	2.10
Bank A	1.43	3.33
Mean: 2.37		

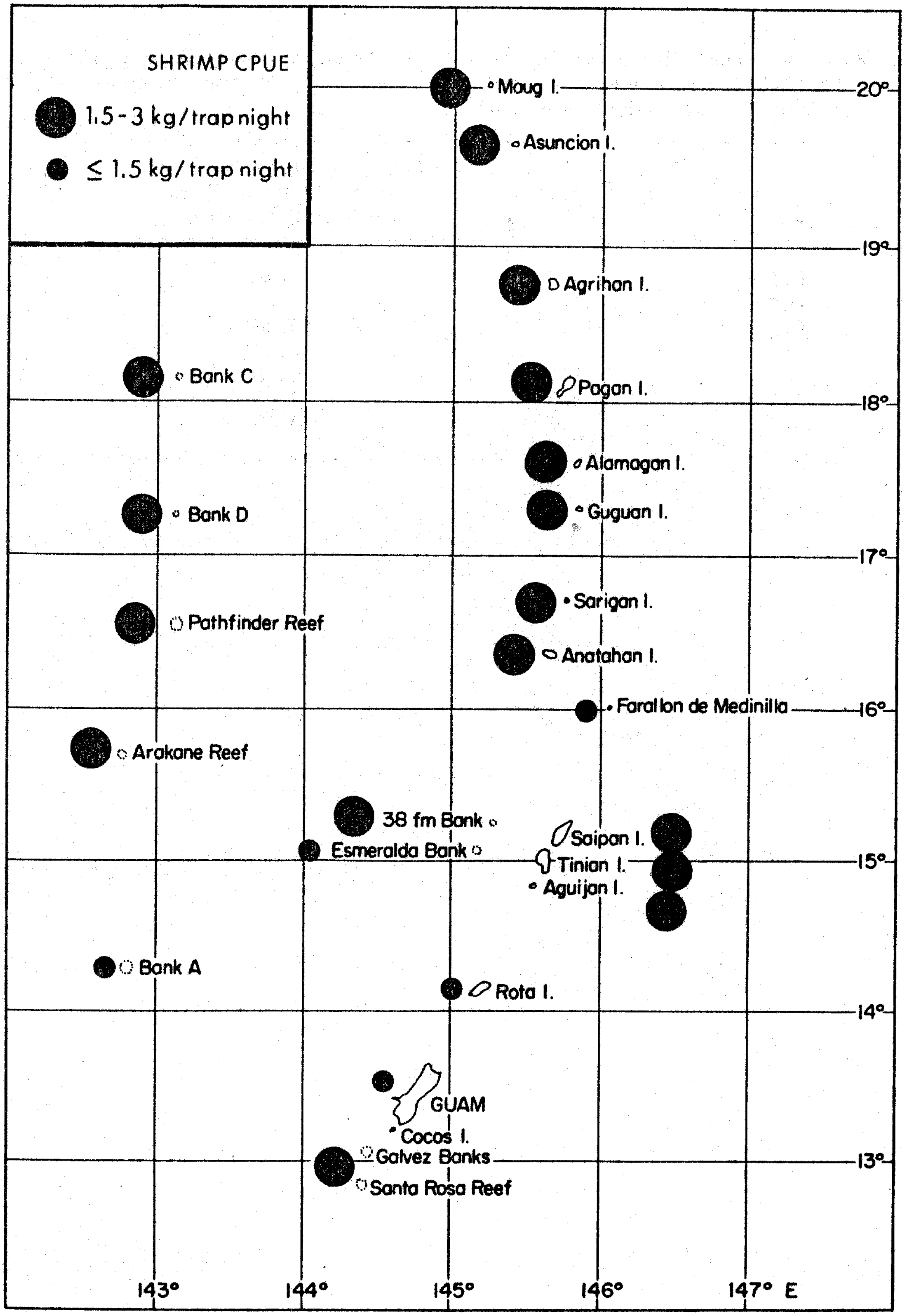

Figure 4.--Deepwater shrimp CPUE grouped into two catch levels.

Table 10.--Equilibrium yield (in MT) for *Heterocarpus laevigatus* in the 500-825 m depth range and relative spawning stock biomass as a function of fishing mortality (F).

F	Total yield (MT) in 500-825 m depth	Spawning stock biomass under F/unexploited spawning biomass
0.1	56.3	0.70
0.2	95.6	0.51
0.3	124.2	0.37
0.4	145.1	0.27
0.5	161.5	0.20
0.6	174.1	0.15
0.7	181.1	0.11

Table 11.--Equilibrium yield for Heterocarpus in the 500-825 m depth range (in MT).

Bank		Yield (MT/yr)[1]
Northern Islands and Banks		
Maug		0.9
Asuncion		1.5
Aguijan		3.0
Pagan		4.3
Alamagan		3.0
Guguan		1.7
Sarigan		0.8
Anatahan		3.1
38-Fathom		1.7
Esmeralda		0.3
	Total	20.3
Southern Islands and Banks		
Farallon de Medinilla		10.6
Saipan		54.1
Tinian		16.3
Aguijan		7.8
Rota		24.7
Guam		3.9
Galvez and Santa Rosa		20.2
	Total	137.6
Seamounts		
Bank C		0.7
Bank D		0.9
Pathfinder		0.9
Arakane		0.5
Bank A		0.6
	Total	3.6
Archipelago total: 161.5		

[1]Based on a fishery mortality of 0.50.

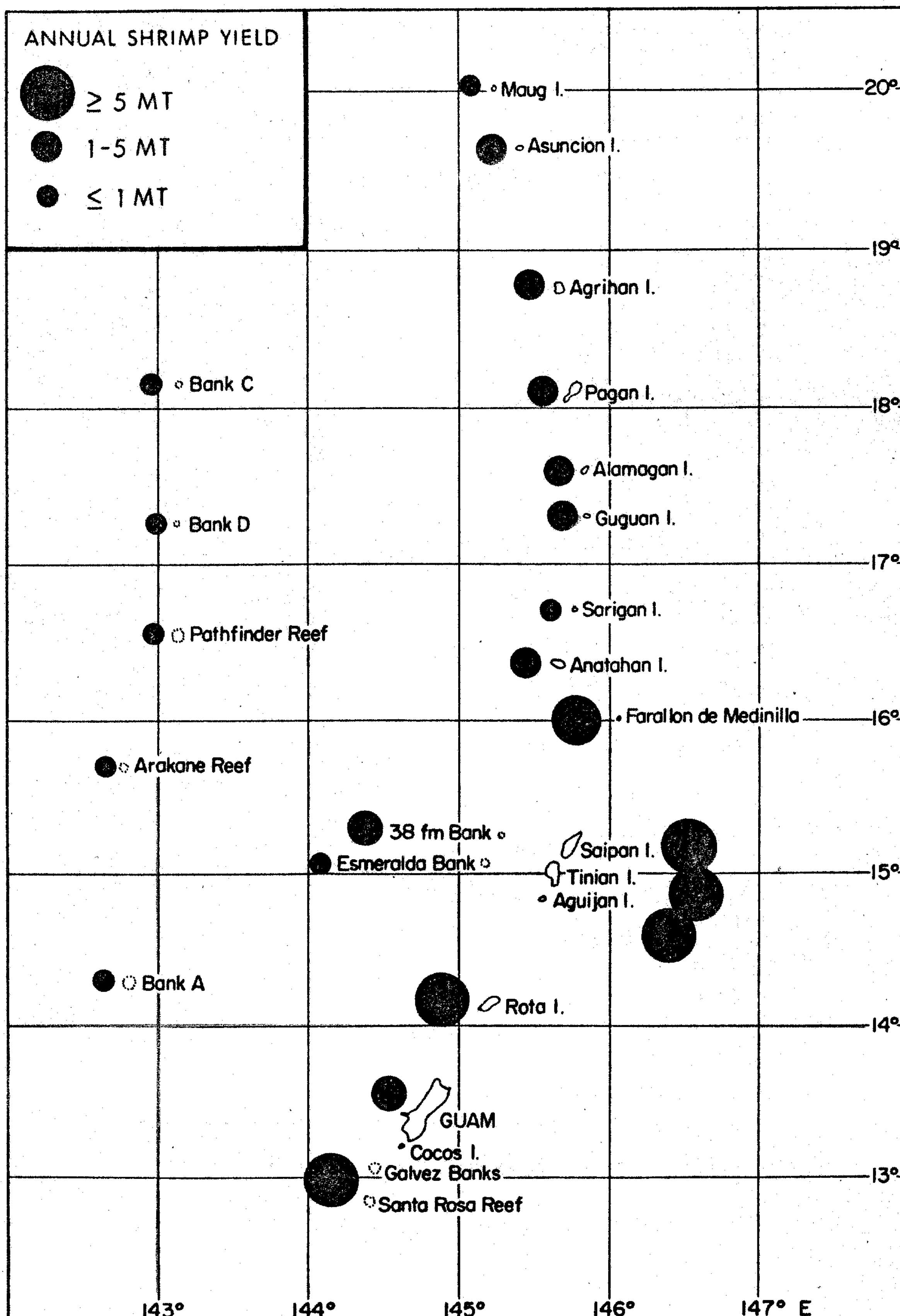

Figure 5.--Annual deepwater shrimp yield grouped into three yield levels.

OTHER RESOURCES

There is a substantial resource of tunas and other pelagic species around the Marianas. The Japanese longline catch and effort data for the period 1965-79 and Japanese baitboat data for the period 1970-79 within 50 nmi and within the FCZ around Guam and the Commonwealth of the Northern Marianas have been analyzed by Polovina and Shippen (see footnote 2). The total tuna annual catches from Japanese longliners within the FCZ around Guam ranged from 9 to 1,334 MT, and the annual catches within the FCZ around the Commonwealth of the Northern Mariana Islands ranged from 71 to 576 MT. The billfish catches typically were about 10-30% of the total tuna catch. The total annual tuna catches from Japanese baitboats within the FCZ around Guam ranged from 83 to 2,059 MT and the catches within the FCZ around the Commonwealth of the Mariana Islands ranged from 2,554 to 12,564 MT.

Annual catches of pelagic species typically from nearshore trolling which include tunas, mahimahi, wahoo, and billfishes are estimated at about 200 MT for Guam and varied from 40 to 124 MT for Saipan (Tables 6 and 7).

Although the Japanese catches indicate that the magnitude of the pelagic resource is large it is also widely dispersed. Fish aggregating devices are widely used throughout the Pacific and appear to be useful as a means of aggregating the pelagic species and hence increasing the catches, but the frequency of typhoons in the Marianas is an impediment to their application. The expansion of the charter fishing industry may have potential as a means of further exploiting the tuna and billfish resources given the strong tourist industry in both Guam and Saipan.

Akule, *Selar crumenophthalmus*, often called atulai, or bigeye scad is a popular resource which is usually netted or hooked in nearshore areas. The reported landings in Guam and the Commonwealth of the Mariana Islands are only about 5 and 1 MT annually, but much of the resource does not go through the usual market channels and is not reported. The RAIOMA Program found akule present at most of the islands and banks but, given the seasonal nature of the resource and effect of moon phase on the catch rates, a systematic survey was not possible. Two aerial surveys were not effective in estimating the nearshore akule biomass. The estimated catch rate of akule in the Hawaiian Islands from 1948 to 1982 vary from 0.4 to 0.9 MT/nmi of 200-m contour. If it is assumed that abundance of akule in the Marianas is equivalent to that in Hawaii, then the Marianas, where the length of the 200-m contour is 490 nmi, would offer a range of harvest from 200 to 440 MT per year. However, most of the catches in Hawaii are by small purse seiners using aerial spotters, and these catches extrapolated to the Marianas may represent upper bounds for the more traditional gear.

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